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Correlation of Ultrasound and MRI in Rotator Cuff Injuries

Dr. Namasya Sri Burugupalli[1], Dr. Praveen Ramegowda[2], Dr. Anand SH[3]

Sri Siddhartha Medical College

Abstract: ***Background: Shoulder pain is one of the most common complaints encountered in orthopaedic department. Rotator cuff pathologies are the most common cause of shoulder joint pain. In addition to a history and physical examination, the evaluation of a patient with shoulder pain often includes rotator cuff assessment using high - resolution ultrasonography or MRI. This study aimed to assess the accuracy of high - resolution ultrasonography in detecting the rotator cuff disorders by correlating with magnetic resonance imaging findings. Objective: 1) To Describe the spectrum of findings in Ultrasonography and Magnetic resonance imaging in rotator cuff injuries. 2) To correlate ultrasonography with magnetic resonance imaging for assessment of rotator cuff injuries. Methods: This study examines the accuracy of high - resolution ultrasonography (USG) in diagnosing rotator cuff injuries by comparing it with MRI findings in 40 patients. Conducted over 18 months at Sri Siddhartha Medical College, the cross - sectional study assesses USG's sensitivity, specificity, and diagnostic accuracy relative to MRI. Results indicate USG's high sensitivity for diagnosing full - thickness tears and its utility as a first - line modality due to accessibility and cost - effectiveness. MRI, however, provides superior imaging details in complex cases. The findings advocate for a complementary use of both imaging techniques to enhance diagnostic accuracy and patient outcomes in shoulder injury assessments. Results: In this research of 40 patients, it was revealed that mean age group as 40 - 50 yr, with a male preponderance (67.5%). We observed that USG had 85% sensitivity to diagnose full thickness tears, and 92 % specificity when compared to MRI. In the overall study, USG had an overall sensitivity of 94%, specificity of 83% and a diagnostic accuracy of 92%. In scenarios where precision and detailed imaging are paramount, MRI outperforms USG by providing superior detection and characterization of subtle abnormalities. Its advanced imaging capabilities lead to more accurate diagnoses and better - informed clinical decisions, underscoring its value in the comprehensive assessment of these conditions. While USG remains an excellent first - line modality due to its safety, accessibility, and cost - effectiveness, MRI's enhanced diagnostic prowess is indispensable in complex cases where finer anatomical details and more definitive assessments are required. Understanding the diagnostic accuracy of both USG and MRI is critical for improving patient management and outcomes in shoulder pain cases, especially when considering factors such as cost, availability, and the need for detailed anatomical visualization in treatment planning. Conclusion: While both MRI and USG are valuable diagnostic tools, USG remains a critical initial diagnostic approach due to its non - invasiveness and accessibility. The study suggests a complementary use of both modalities to enhance diagnostic accuracy and patient outcomes in the evaluation of rotator cuff injuries.***

Keywords: Rotator cuff injuries, Ultrasonography, Magnetic resonance imaging, Diagnostic accuracy, Sensitivity, Specificity, Shoulder pain, Non- invasive imaging

1. Introduction

The glenohumeral joint is a ball - and - socket diarthrodial joint that plays a crucial role in the upper extremity's range of motion. As a synovial joint, it facilitates a wide variety of movements, allowing individuals to engage in numerous activities throughout the day. This joint's unique design offers exceptional flexibility; however, the size disparity between the larger head of the humerus and the shallower glenoid fossa of the scapula renders it more vulnerable to instability.

To counteract this instability, several anatomical features work in tandem. The glenoid labrum, a fibrocartilaginous structure, deepens the glenoid cavity, increasing the contact area with the humeral head and enhancing joint stability. This increased surface area is essential for maintaining the integrity of the joint, especially during dynamic movements.

The rotator cuff is a group of four key muscles—supraspinatus (superior), subscapularis (anterior), teres minor (posterior), and infraspinatus (postero - superiorly) —that encase the glenohumeral joint. These muscles and their associated tendons are pivotal for stabilizing the humeral head within the glenoid fossa during arm movements. The supraspinatus, often considered the most powerful abductor and elevator in the upper extremities, plays a significant role in initiating arm abduction. In conjunction with the deltoid muscle, it contributes to the elevation of the arm, making it essential for overhead activities.

Additionally, the teres minor and infraspinatus provide external rotation torque, crucial for preventing posterior subluxation of the joint. The infraspinatus exhibits a biphasic function, acting as both a mover and depressor during arm elevation and abduction, depending on the specific movement being performed.

The subscapularis, identified as the strongest internal rotator of the glenohumeral joint, plays a vital role in internal rotation, whether the arm is adducted or abducted. Its interaction with the rotator cuff and the long head of the biceps contributes significantly to joint stability, particularly given the shallow nature of the glenoid fossa. The labrum compensates for this by increasing the articular surface area, further enhancing stability.

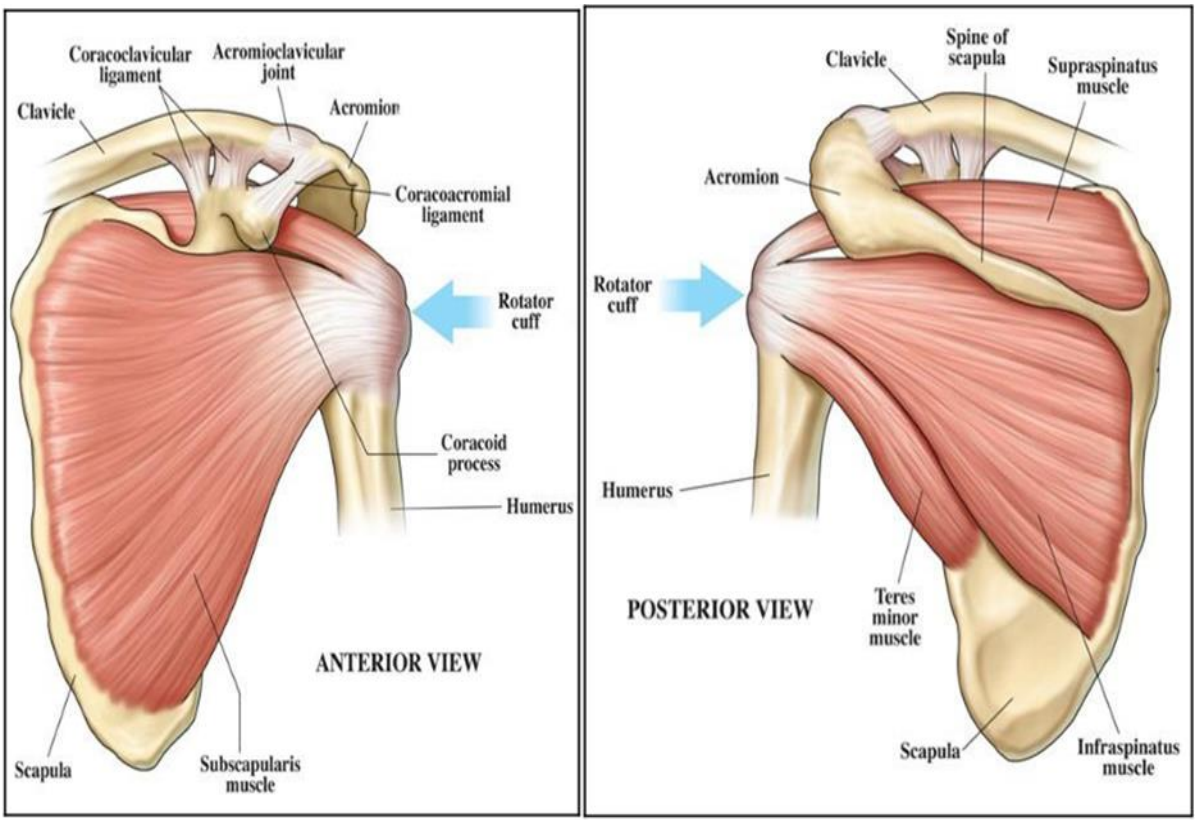

Figure 1: Images illustrating the rotator cuff muscles and tendons

Research has highlighted the relative contributions of the rotator cuff muscles in different positions. In isometric conditions, the subscapularis contributes nearly half of the strength needed to stabilize the joint, while the infraspinatus accounts for slightly over 22%. Isokinetic assessments have shown that the supraspinatus and infraspinatus provide approximately 50% of the strength necessary during abduction and external rotation.

In terms of clinical assessment, ultrasonography (USG) is a valuable tool for diagnosing shoulder impingements and rotator cuff tendinopathy. It offers a quick, dynamic, and cost - effective method for evaluating shoulder conditions, providing results that are comparable to MRI when it comes to full - thickness rotator cuff tears. However, USG has limitations, particularly in identifying partial thickness injuries and relies heavily on the operator's skill for accurate interpretation.

Magnetic resonance imaging (MRI), due to its non - invasive nature, has emerged as the imaging modality of choice in many cases. MRI provides high spatial resolution of bone, cartilaginous tissue, and soft tissue structures, offering critical anatomical information about tendon injuries, including size, extent, and location. This detailed information is essential for determining treatment strategies, including the feasibility of surgical interventions. MRI is commonly used to evaluate shoulder issues such as impingement and instability, as well as to monitor the progression of conditions like rotator cuff tendinopathy.

Given the strengths and limitations of both imaging modalities, this study aims to assess the effectiveness of ultrasonography compared to magnetic resonance imaging in diagnosing shoulder disorders in patients presenting with shoulder pain. Understanding the efficacy of these diagnostic tools is crucial for optimizing patient management and treatment outcomes.

2. Methodology

This cross - sectional study was conducted on patients with clinical suspicion of rotator cuff problems, patients were directed to the radiology department for shoulder MRIs and ultrasound examinations. The study was conducted in the Department of Radiology, Sri Siddhartha Medical College & Research Centre Hospital, Tumkur, over a period of 18 months. The imaging was done using Voluson S8 core BT 18 machine and SIEMENS ESSENZA 1.5 tesla MRI scanner using body coil. Routine imaging sequences will be done. Diagnosis will be confirmed with clinical and operative /arthroscopic findings.

Inclusion Criteria:
All patients who were referred to the radiology dept with clinically suspected rotator cuff injury.

Exclusion Criteria:
The patients meeting the following criteria were excluded from the study.

- Uncooperative patients.
- Patients with metallic implants.
- Patients with pacemaker / cochlear implant in - situ.
- Patients with claustrophobia/ any other psychiatric abnormality.
- Individuals who have undergone prior shoulder surgery or shoulder implants.

3. Results

A hospital based cross sectional study was carried out in Sri Siddhartha Medical College, Tumkur over duration of 18 months. All the 40 patients who were referred from outpatient and inpatient departments of SSMC who presented with shoulder pain were subjected to Ultrasonography and MRI.

Table 1: Age distribution of patients

Age (in years)	Frequency	Percent
20 - 30	8	20.0
31 - 40	9	22.5
41 - 50	11	27.5
51 - 60	6	15.0
>60	6	15.0
Total	40	100.0

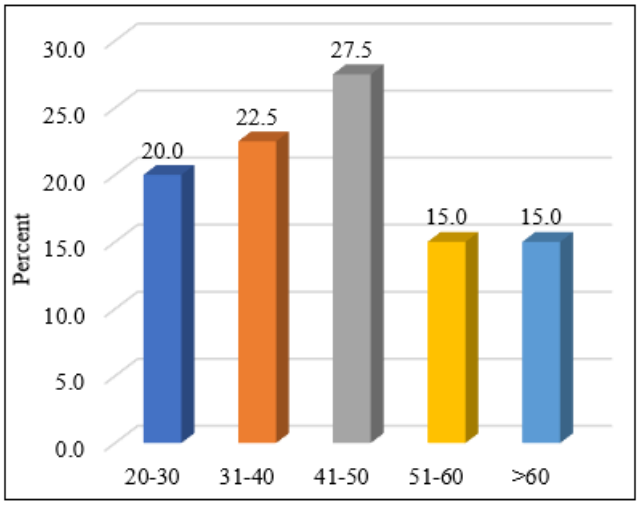

Figure 7: Age distribution of patients

Table 2: Gender distribution of patients

Sex	Frequency	Percent
Male	27	67.5
Female	13	32.5
Total	40	100.0

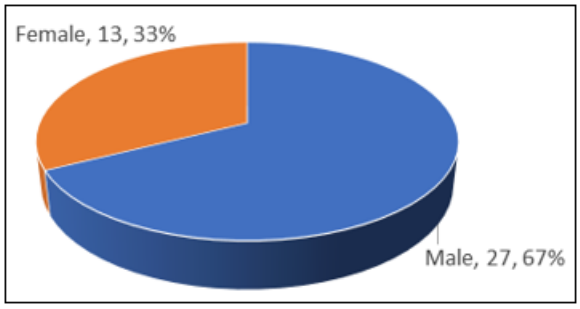

Figure 8: Gender distribution of patients

Table 6: Side of the Complaints

Side of Complaint	Frequency	Percent
Right	21	52.5
Left	15	37.5
Bilateral	4	10.0
Total	40	100.0

		MRI Muscle Group Involved			Total
		Supraspinatus	Subscapularis	Infra - spinatus	
USG Muscle Group Involved	Supraspinatus	25 (100%)	0 (0.0%)	0 (0.0%)	25 (62.5%)
	Subscapularis	0 (0.0%)	10 (100%)	0 (0.0%)	10 (25.0%)
	Infraspinatus	1 (2.5%)	0 (0.0%)	4 (10.0%)	5 (12.5%)
	Teres minor	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Total	26 (65.0%)	10 (25.0%)	4 (10.0%)	40 (100%)
Kappa Agreement, P - value		0.952, <0.001			

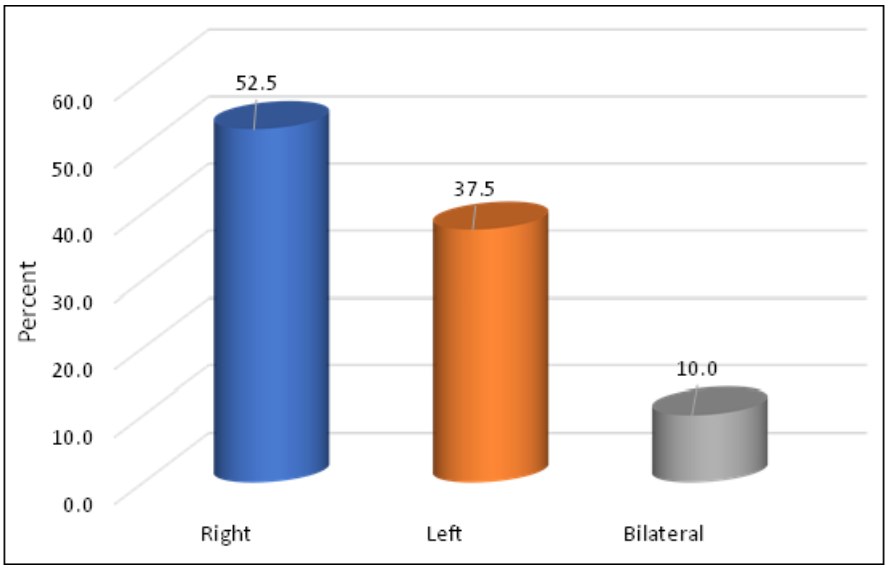

Figure 12: Side of the Complaints

Table 7: USG and MRI findings of Muscle group involvement

Side of Complaint	Frequency	Percent
Right	21	52.5
Left	15	37.5
Bilateral	4	10.0
Total	40	100.0

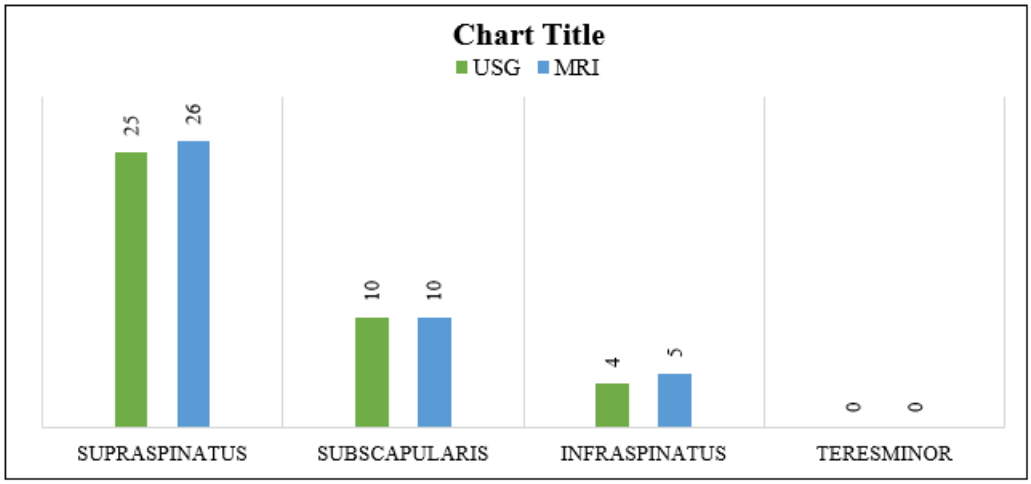

Figure 13: Muscle group involvement in USG and MRI

Table 8: USG and MRI findings of Tear Type

		MRI Tear Type			Total
		Partial Thickness Tear	Full Thickness Tear	No Tear	
USG Tear Type	Partial Thickness Tear	13 (93.8%)	3 (18.8%)	0 (0.0%)	16 (100%)
	Full Thickness Tear	4 (57.1%)	3 (42.9%)	0 (0.0%)	7 (100%)
	No Tear	1 (5.9%)	0 (0.0%)	16 (94.1%)	17 (100%)
	Total	18 (52.5%)	6 (32.5%)	16 (15.0%)	40 (100%)
Kappa Agreement, P - value		**0.720, <0.001**			

Table 9: USG and MRI findings of Acromioclavicular Joint Arthrosis

		MRI AC Joint Arthrosis		Total
		Yes	No	
USG AC Joint Arthrosis	Yes	24 (96.0%)	1 (4.0%)	25 (100%)
	No	0 (0.0%)	15 (100%)	15 (100%)
	Total	24 (60.0%)	16 (40.0%)	40 (100%)
Kappa Agreement, P - value		0.947, <0.001		

Table 10: USG and MRI findings of Tendinosis

		MRI Tendinosis		Total
		Yes	No	
USG Tendinosis	Yes	27 (100%)	0 (0.0%)	27 (100%)
	No	1 (7.7%)	12 (92.3%)	13 (100%)
	Total	28 (70.0%)	12 (30.0%)	40 (100%)
Kappa Agreement, P - value		0.942, <0.001		

Table 11: USG and MRI findings of Biceps

		MRI Biceps		Total
		Involved	Not Involved	
USG Biceps	Involved	17 (100%)	0 (0.0%)	17 (100%)
	Not Involved	2 (8.7%)	21 (91.3%)	23 (100%)
	Total	19 (47.5%)	21 (52.5%)	40 (100%)
Kappa Agreement, P - value		0.899, <0.001		

Table 12: USG and MRI findings of Joint Effusion

		MRI Joint Effusion		Total
		Yes	No	
USG Joint Effusion	Yes	26 (92.9%)	2 (7.1%)	28 (100%)
	No	4 (33.3%)	8 (66.7%)	12 (100%)
	Total	30 (75.0%)	10 (25.0%)	40 (100%)
Kappa Agreement, P - value		0.625, <0.001		

Table 13: USG and MRI findings of Bursitis

		MRI Bursitis		Total
		Yes	No	
USG Bursitis	Yes	28 (96.6%)	1 (3.4%)	29 (100%)
	No	0 (0.0%)	11 (100%)	11 (100%)
	Total	28 (70.0%)	12 (30.0%)	40 (100%)
Kappa Agreement, P - value		0.939, <0.001		

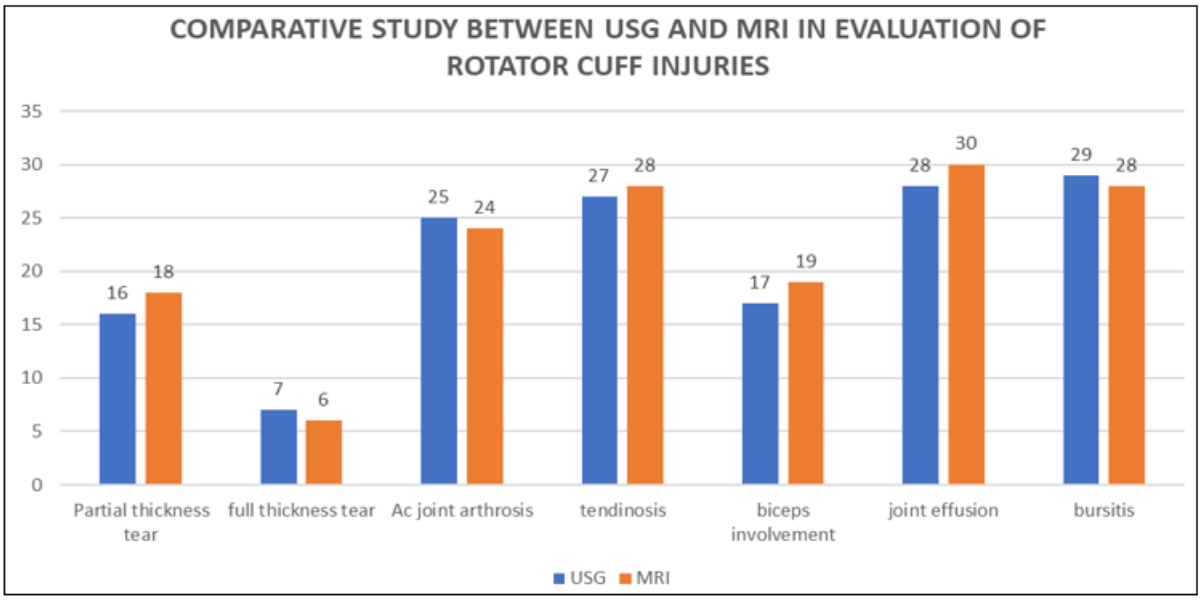

Figure 14: Comparative study between USG and MRI in evaluation of Rotator cuff injuries

4. Discussion

In this investigation, 40 participants with shoulder joint imaging were included. The subjects' rotator cuff anomalies were evaluated.

Age Distribution:
The age range that is most common in our research population was 40 - 50 years. The results of our investigation, which align with those of Fischer et al (76) investigation, in which mean age was 68.3 years.

Bashir et al (77) noted that the prevalence of shoulder pain was observed to increases with the increasing age. The highest number of patients was observed in age group 61 years and above (40%). Night pain was present in 24 patients out of 50 patients.

Gender Distribution:
67.5% were men and the rest were women. Our research and subsequent studies have shown that women experience rotator cuff problems more frequently than men do. This is most likely because of the way women are built overall.

In Fischer et al (76), 28 women, 17 men. Additionally, they did not find any statistically significant variations between gender and the occurrence of rotator cuff tears.

Bashir et al (77) noted that there were 28 (56%) males and 22 (44%) females. Thus, the male: female ratio is 1.3: 1. They found statistically no discernible change in the prevalence of shoulder pain related to gender.

Side of Lesion:
In the present study, 21 patients had right side involved, while 15 had left side involved and 4 had bilateral involvement. It suggests that dominant arm is more susceptible to wearing effects and thus leads to rotator cuff injuries.

In a study by Fisher et al, (76) patients had right - sided and 20 patients left - sided shoulder involvement. This was higher than the findings of our study, but right side being common corroborates with our observation.

In a study by Bashir et al (76), the number of patients with right shoulder pain was 42 (84%) and left shoulder pain was 8 (16%). Out of 33 patients who were right - handed, 32 patients had RCT involving the right shoulder and 1 had RCT involving the left shoulder. Out of 5 patients who were left - handed, 3 patients had RCT involving the left shoulder and 2 had RCT involving the right shoulder. It suggests that dominant arm is more susceptible to wearing effects and thus leads to RCT.

This is contradictory with the findings of the study by Bouaziz et al, which revealed significant involvement of the right shoulder was more frequent than the left involvement (68%) in that study.

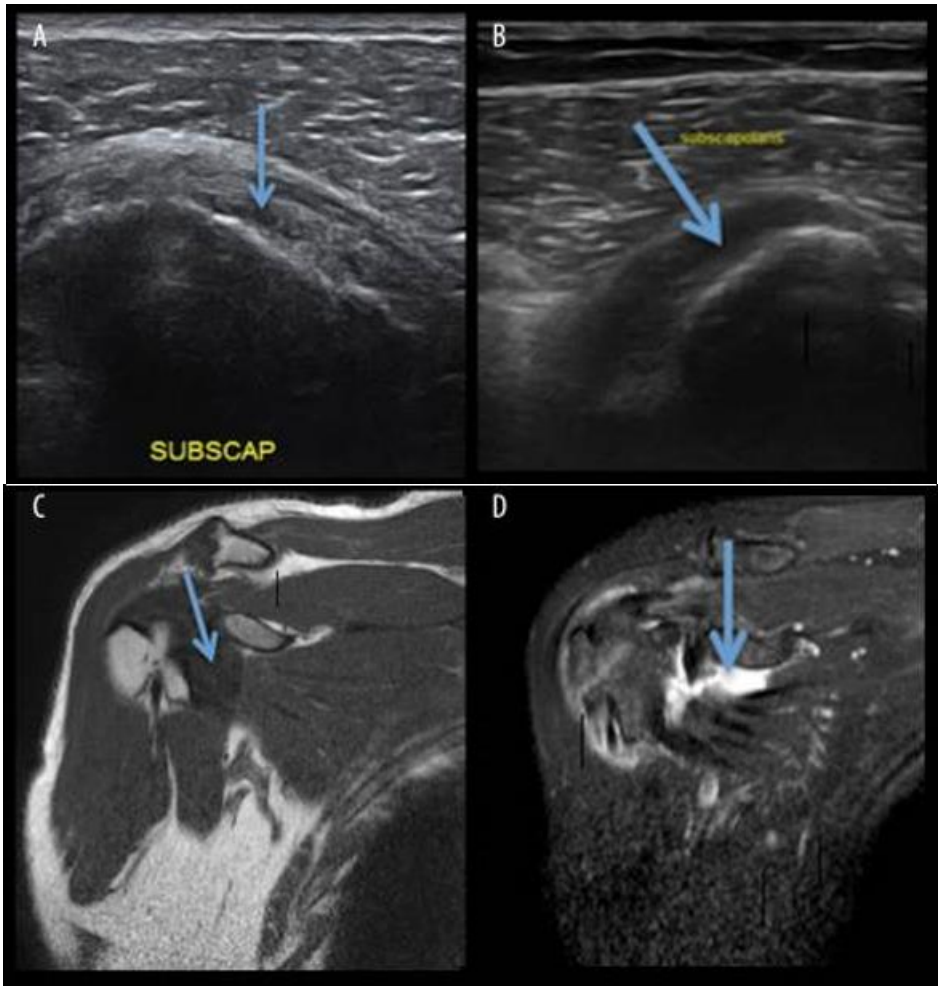

Figure 17: (A) USG image showing a normal subscapularis tendon (B) USG image showing a complete tear of the subscapularis tendon (C) MRI, T1W coronal image depicting a normal subscapularis tendon (D) MRI, T2W coronal image depicting a full - thickness tear of the subscapularis tendon (arrow marked).

The kappa coefficient was used to evaluate the agreement between the two approaches (Kappa= 0.818). For the diagnosis of rotator cuff tears, the degree of agreement between USG and MRI is regarded as "very good. " Rutten [80] and Alasaarela et al. [79] also produced findings that were comparable. In their evaluation of thirty patients with 31 sore shoulders, Alasaarela et al. [79] found that US and MRI agreed well in diagnosing full thickness rips and intrasubstance anomalies of the supraspinatus tendon (kappa coefficient = 0.73). Rutten [80] analyzed data of 68 patients who underwent MRI and surgery following USG examination and reported that agreement between US and MRI was high (the kappa coefficient was calculated to be 0.78).

Rutten [80] studied 68 patients and concluded that the diagnostic performances of high - resolution US and MR imaging in the detection of partial and full thickness tears of rotator cuff is comparable, demonstrating an accuracy of 87% and sensitivities and specificities of over 90% respectively.

5. Conclusion

Due to its affordability, speed, accessibility, dynamic nature, lack of radiation exposure, ease of use, ability to perform at the patient's bedside, and overall patient comfort, ultrasound (USG) rotator cuff examination is extremely competitive when compared to magnetic resonance imaging (MRI).

However, the USG places a great deal of emphasis on the examiner's background and established examination standards. In diagnosing subscapularis tears in individuals with restricted range of motion, particularly in external rotation, USG is less reliable than MRI.

We believe that USG is particularly useful for the preoperative evaluation of the long biceps tendon and the rotator cuff in revision patients, where metallic implants frequently cause MRI quality to be compromised.

USG diagnosis of the rotator cuff is especially beneficial for individuals with claustrophobia, pacemakers, or other MRI exclusion factors.

Both ultrasound and MRI serve as valuable diagnostic tools for rotator cuff injuries, with USG offering an accessible and cost - effective first - line option. However, MRI provides superior imaging in complex cases, making it indispensable for comprehensive assessment. This study underscores the benefit of a complementary approach, optimizing diagnostic accuracy and informing treatment decisions.

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